



## technology opportunity

# Compact Low-Loss Planar Magic-T



NASA Goddard Space Flight Center (GSFC) invites companies to license its new compact low-loss planar Magic-T, which boosts signal receptivity for improved measurements by microwave and millimeter-wave antenna networks. The invention reduces signal loss, improves broadband response, and offers simplified integration. The Magic-T is also less expensive than other methods to produce and maintains good in-band performance.

## Benefits

- **High bandwidth:** Provides 40% more bandwidth than other Magic-T devices
- **Reduced errors:** Exhibits significantly fewer errors than typical, 3-dimensional Magic-Ts (1 degree for planar vs. 5 degrees for typical Magic-Ts)
- **Lower cost:** Is significantly less expensive to manufacture—by a factor of 10 to 30—than various common devices
- **Lower losses:** Offers high isolation between ports, resulting in broader bandwidth as well as reduced signal, radiation, and insertion losses
- **Simplified integration:** Features a planar design that enables use with integrated circuits, such as monolithic and monolithic microwave integrated circuits (MICs and MMICs)

## Applications

- Beam-forming networks
- Antenna transmissions
- Remote-controlled aircraft
- Polarization and other discrimination and measurement applications
- Radar receive/transmit applications
- Cell phone towers and other wireless communications
- Cable TV
- Radiometry and astronomical measurements
- Surveillance and security

## Technology Details

The compact low-loss planar Magic-T provides a broadband level of passive microwave/millimeter-wave signal power combining for both in-phase and out-of-phase ports. The technology achieves high isolation despite its compact design. Simple to make, it uses only two metallic layers and requires no bond wires, via-holes, or air bridges. The technology's simplified design provides high reliability and improved signal receptivity in microwave applications.

### *How It Works*

The compact low-loss planar Magic-T uses a highly symmetric layout that enables minimal dependence on transmission-line phase variation. As a result, this technology has high isolation and phase balance, broadband response, and low insertion loss in the operating band.

The device has four ports and allows microwave signals from two ports to combine in-phase on one port and out-of-phase on a second port. The in-phase signal combiner transmission lines are combined at the microstrip line junction. The out-of-phase signal combiner transmission lines are combined and transformed into a slotline. The microstrip line complements the slotline to create an extraordinary broadband phase inverter.

### *Why It Is Better*

There are two main alternatives to GSFC's technology: waveguide Magic-Ts and traditional planar Magic-Ts. Most Magic-Ts using waveguides can handle high power and have low phase mismatch, but they are expensive and heavy. Traditional planar Magic-Ts offer lighter weight but often have limited bandwidth and power-handling capability, or they suffer high phase deviation and insertion loss in the operating band. In addition, traditional planar Magic-Ts rely on delay lines to combine and divide out-of-phase power, which limits

the devices to a very narrow frequency band. Some use elements with high radiation loss to perform this function, but this approach leads to a design with either high insertion loss or poor phase balance.

In contrast to the above technologies, GSFC's compact low-loss planar Magic-T makes use of a completely different methodology, relying instead on the symmetry of electrical and magnetic fields and enabling a broadband response without delay lines or waveguides. The result is a device with improved performance (i.e., higher bandwidth as well as reduced signal errors and losses); lower fabrication cost; and a smaller, lighter footprint. Because it has no moving parts, it requires low to no maintenance. The design also reduces the signal, radiation, and insertion losses common in more complex designs (often due to unequal phase delay between two input ports), and offers less sensitivity to fabrication misalignment. The device can be easily integrated with MICs and MMICs, which makes simpler electronic designs possible.

### *Patents*

NASA Goddard Space Flight Center is seeking patent protection for the technology.

### *Licensing and Partnering Opportunities*

This technology is part of NASA's Innovative Partnerships Program (IPP), which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Compact Low-Loss Planar Magic-T (GSC-15470-1) for commercial applications. For information and forms related to the technology licensing and partnering process, please visit the Licensing and Partnering page on Goddard's IPP Office Web site (<http://ipp.gsfc.nasa.gov/lic-partnerships.html>).

## For More Information

If you would like more information or want to pursue transfer of this technology, please contact:

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